



DEVICES,

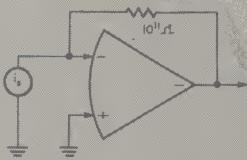
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Model 301 DIFFERENTIAL OPERATIONAL AMPLIFIER ULTRA LOW INPUT CURRENT AND NOISE

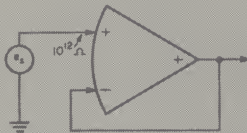
New varactor bridge op amp achieves input current of only 1 pA with 10^{12} ohms input impedance (CM). 1/f noise is reduced to 1 μ V and 0.01 pA peak to peak.

Common Mode Voltage is ± 300 V with 10^8 CMR. Encapsulated 3 cu. in. P.C. mounting module has 10^6 gain and ± 10 V and 20 mA output.

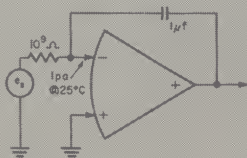
APPLICATIONS



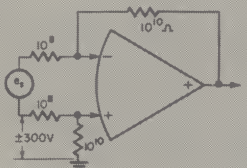
OFFSET CURRENT CHANGE
of only 30 pA from -25° to $+75^\circ$ C, plus 0.01 pA noise, enables current amplifier to resolve 10^{-13} amp inputs, builds 9 decade log amplifiers.



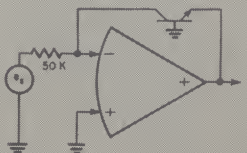
COMMON MODE IMPEDANCE
of 10^{12} ohms, 1 μ V p-p noise, 10^8 CMRR, and only 30 μ V/ $^\circ$ C max. drift, provide basis for rugged electrometer amplifiers with 10^{12} ohms input impedance.



LOW OFFSET CURRENT
of 1 pA, plus 10^{10} ohms differential input impedance, permits 1,000 sec time constant for integrators, also builds excellent sample hold circuits.



COMMON MODE VOLTAGE
of ± 300 V combined with low offset current allows different amplifiers to use 10^8 ohm input resistors, and to resolve millivolt signals on 300 V inputs.



LOW DC NOISE
and low offset enable log amplifiers to use full dynamic range of logarithmic feedback elements, hence accommodate 180 db input signal range.

DESCRIPTION

Model 301 DC differential operational amplifiers' remarkable combination of offset, drift, noise, common-mode, and input impedance specs enables current amplifier to resolve 10^{-13} amps input, permits integrators to operate with 1,000 second time constant, gives electrometer or voltage follower amplifiers 10^{12} ohms input impedance, furnishes difference amplifier's millivolt signal resolution for ± 300 volt common mode inputs, and yields logarithmic amplifier's 9 decade dynamic range.

NOISE

Based on the same fundamental principles as parametric microwave amplifiers, but using radically different varactor circuitry, Model 301 inherently eliminates 1/f or "flicker" noise, achieving DC-1 Hz noise specs of 1 μ V and 0.01 pA peak to peak. No other solid state technique yields such low noise performance.

LOW OFFSET CURRENT

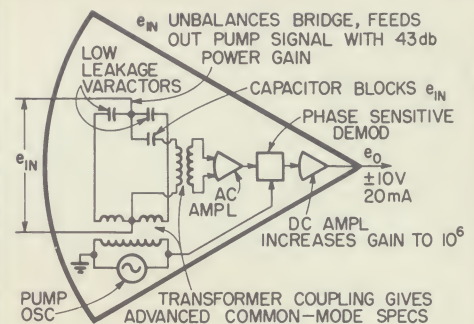
The matched, low leakage varactors used in Model 301, ensure offset performance ten, to one hundred, times better than FET operational amplifiers. This new PC mounting unit can measure exceedingly low input levels, and accommodate large value input resistors, because the offset current: 1 pA at 25° C, rising to only 20 pA at 65° C, is small relative to signals being measured. Current variations as low as 10^{-13} amps can readily be distinguished, while input resistors as high as 10^{10} ohms, and feedback resistors to 10^{12} ohms increase circuit flexibility enormously. The amplifier's own differential input impedance is 10^{10} ohms.

COMMON MODE

Transformer coupling between amplifier input (the varactor bridge), and the remainder of the amplifier's internal circuitry, provides three important common mode characteristics. Exceedingly high resistance to ground — afforded by careful transformer design — provides a common mode input impedance of at least 10^{12} ohms, plus C.M.R.R. of 160db. In addition, the transformer isolated input stage sustains common mode voltage levels of ± 300 Volts.



HOW MODEL 301 WORKS



Amplifier input, e_{in} , varies varactor capacitances, unbalances bridge, and develops pump voltage output proportional to bridge unbalance.

After low noise AC amplification, the output pump voltage is phase-sensitively demodulated to restore correct polarity, then further boosted by the DC amplifier.

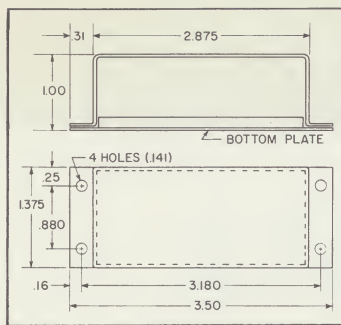
Final output is a replica of the original signal, amplified one million times.

Matched low leakage varactors inherently eliminate 1/f noise, give excellent offset and drift specs, and provide 10^{10} ohms differential input impedance. Transformer coupling is responsible for the amplifier's advanced common mode characteristics.

FEATURES

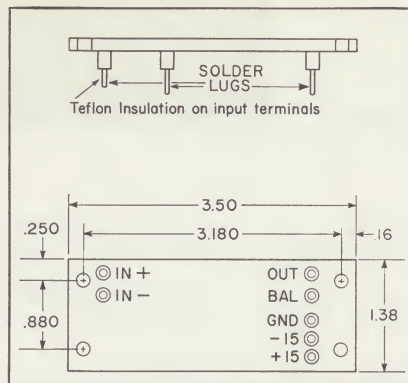
Low Offset1 pA @ 25° C
Low Drift0.06 pA/ $^\circ$ C @ 25° C
Low DC Noise0.01 pA and 1 μ V, p-p
High Impedance $10^{10}\Omega$ (Diff); $10^{12}\Omega$ (CM)
High CM Voltage ± 300 V, 10^8 CMR
Large Output ± 10 V @ 20 mA
High Gain 10^6 , open loop
Small Size3 cu. in., PC mounting

Noise Shield — AC1106 — \$7.00

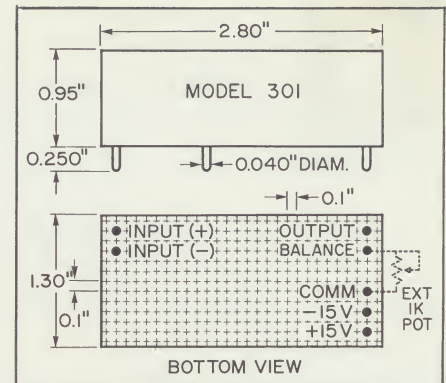


Noise shield is recommended for external circuit impedance greater than 10⁶ ohms to reduce noise pickup.

Mating Socket — AC1006 — \$3.75



Outline Dimensions



SPECIFICATIONS

(typical at 25°C and ±15 VDC unless noted)

Open Loop Gain (Fig. 1)

@ DC, rated load, min. 5×10^5

Rated Output

Voltage, min. ± 10 V
Current, min. ± 20 ma

Frequency Response

Unity gain, small signal 500 KC
Full Power Response, min. 5 KC
Slewing Rate, min. 0.3 V/ μ sec
Overload Recovery 200 μ sec

Input Voltage Offset

Initial Offset at 25°C adj. to zero ext.
vs. temp (-25 to 85°C), $\pm 30 \mu$ V/°C
max. avg.
vs. supply voltage 30 μ V/%

Input Current Offset (each input)

Max. Offset @ 25°C ± 1 pa
Max. Offset @ 65°C ± 20 pa
vs. temperature (see Fig. 2) 6%/°C of local value
doubling each 9.5°C
vs. supply .001 pa/%

Input Impedance

Between Inputs (see Fig. 2) $10^{10}\Omega$, 500 pf
Common Mode (-25 to 85°C) $10^{12}\Omega$, 10 pf

Input Noise (Fig. 3)

Voltage Noise, DC to 1 cps, p-p 1μ V
1 to 100 cps, rms max. 1.5μ V
Current Noise, DC to 1 cps, p-p .01 pa
1 to 100 cps, rms 0.3 pa

Input Voltage

Max. Between Inputs ± 20 V
Max. Common Mode ± 300 V
Common Mode Rejection 10^8

Power Supply

Voltage $\pm (15 \text{ to } 16)$ VDC
Current, Quiescent, max. ± 12 , -15 ma

Temperature Range

Operating -25 to 85°C
Storage -55 to 85°C

Price

1-9 \$198.00
10-24 \$193.00

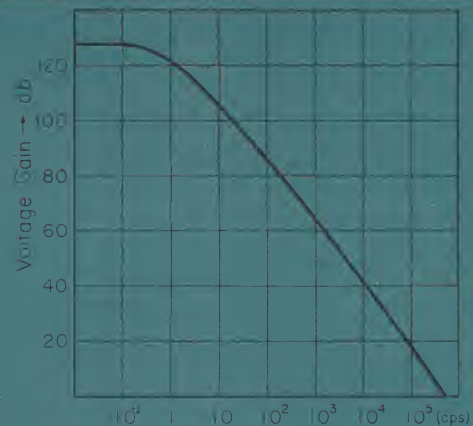


Fig. 1 Open Loop Frequency Response

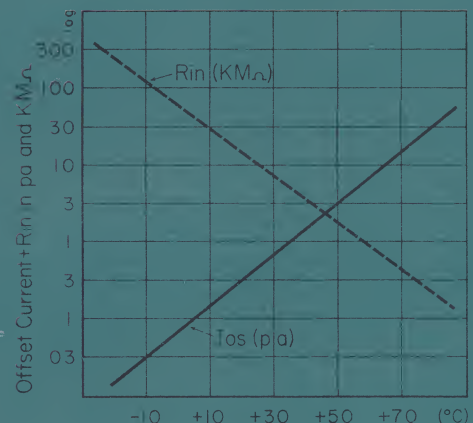


Fig. 2 Offset Current and R_{IN} vs. Temperature

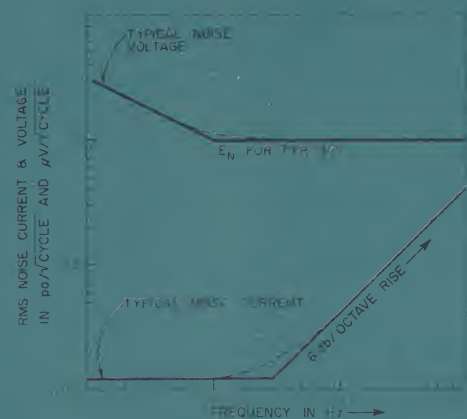


Fig. 3 Input Noise vs. Frequency



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